The Concentration Glass: A New Glassy State? DMR-0307084

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- *Structural recovery (physical aging) after chemical activity-jumps (RH or PCO_2) is qualitatively similar but quantitatively very different from that after temperature-jumps.*
  - *Retardation times are much longer for the same volume departure from equilibrium δ. (Figure 1)*
- *Showed that the "concentration" glass is a different glass from the "temperature" glass. The concentration glass is not equivalent to a temperature-hyper quench formed glass. (Figure 2)*
- ***First direct demonstration of quantitative differences between concentration- and temperature-glasses.***
- *Novel mass uptake measurements during structural recovery are now underway.*
- *Preliminary tests of Non-resonant Spectral Hole Burning Dielectric Spectrometer have been performed. Work aims to look at dynamic heterogeneity of concentration glasses*

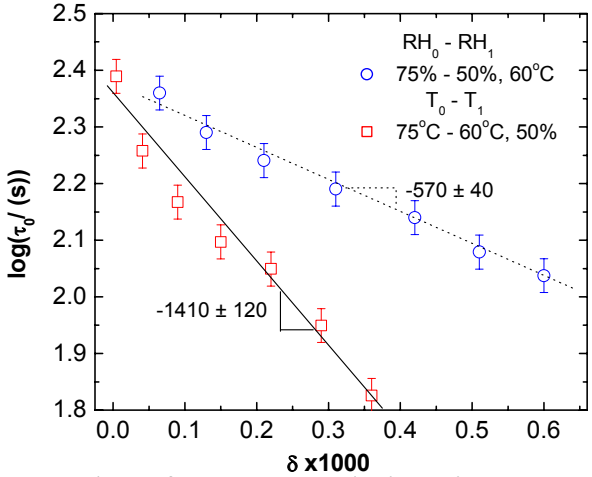

Fig. 1. Plot of creep retardation time vs. δ for temperature-glass (red) and concentration-glass (blue) showing that the concentration glass is more stable (retardation times are longer).

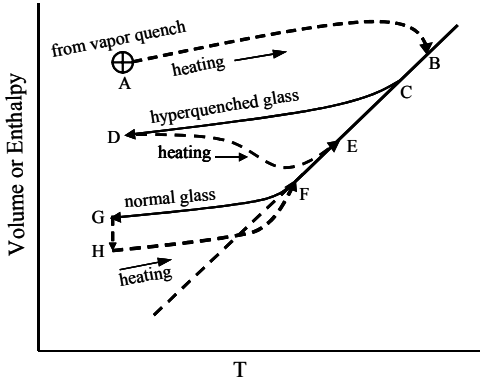

Fig. 2. Schematic of difference between a temperature hyper-quenched glass and a concentration glass in enthalpy or volume vs. temperature space.

The work in FY 2004 further examined the differences between temperature and concentration glasses. Figure 1 here shows the differences in creep responses as the retardation time for two glasses. The blue data points are for a glass formed from a relative humidity (RH)-jump through the glass transition and the red points show the normal path or temperature-jump through the glass transition. Clearly, for a given volume departure from equilibrium, the concentration glass is "more stable" or has a longer retardation time than does the temperature-glass. In Figure 2 we show an interpretation of our results of volume measurements on a carbon dioxide-created glass when compared with a temperature hyper quenched glass. The volume (or enthalpy) of the PCO2 glass does not recover towards equilibrium until above the nominal Tg while the hyper-quenched glass begins changing near to or below the nominal glass transition. The hyper-quench schematic comes from Berens and Hodge, Macromolecules, 15, 756 (1982) and we have modified it to make our point about the PCO2 created glass being different. This figure is in press at Polymer.

Broad Accomplishments-FY2005

NSF Grant DMR-0307084

- ***Education and Outreach***
  - ***Project results presented at national and international meetings***
    - ***Society of Rheology in Oct. 2003.(oral presentations by Y.Zheng, grad. student; M. Alcoutlabi, post-doc)***
    - ***Rubber Hall of Fame Induction of J.D. Ferry, Nov. 2003 (invited presentation by G.B. McKenna, PI)***
    - ***American Physcial Society in March 2004 (oral presentation by G.B. McKenna, PI)***
    - ***Society of Plastics Engineers ANTEC in May 2004 (International Award presentation by G.B. McKenna, PI; oral presentation by L. Banda, grad. student)***
    - ***North American Thermal Analysis Society, October 2004 (L. Banda, grad. Student to give oral presentation.His submitted manuscript was awarded Best Student Paper Award).***
  - ***Project results presented at one regional meeting***
    - ***NaTex in April 2004 (poster presentations by M. Alcoutlabi, L. Banda, graduate student)***
- ***Project results presented at U.S. and International Universities and National Labs by PI***
  - ***NIKE corporation, March 2004 (G.B. McKenna, PI gave invited lecture)***
  - ***Arizona State University, April 2004 (G.B McKenna, PI gave invited lecture to Chemistry Department)***
  - ***Colorado School of Mines, April 2004 (G.B. McKenna, PI gave invited lecture to Chem. Engn. Dept.)***
  - ***Mississippi State University, May 2004 (G.B. McKenna, PI gave invited lecture to Polymer Science Dept.)***
  - ***University of Messina,Italy, July 2004. (G.B. McKenna, PI gave two invited lectures to graduate students in Physics Department)***
- ***Publication***
  - ***2 manuscripts published or accepted (J. Polym. Sci., B. Polym.Phys., 42, 2107-2121 (2004); Polymer, in press)***
  - ***3 proceedings publications***
  - ***1 manuscript in review (Phys. Rev. Lett.)***